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PATENT- OG VAREMÆRKESTYRELSEN

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A microphone and a method for its manufacture.

The invention relates to a microphone component comprising a piezoelectric transflexural diaphragm element, a signal interface element, support elements and a mechanically protective front surface.

Microphones are known, in which the transducing element is a compound diaphragm giving an electrical output when exposed to bending. This may be obtained in the form of what has been termed a piezoelectric transflexural diaphragm, which is in fact a very thin piezoelectric layer, one side of which is usually bonded to a metal diaphragm and which has a metal layer deposited on the other side. This laminate reacts to shear stresses in the piezoelectric layer occuring when the diaphragm is bent inwards and outwards by generating a voltage difference between the metal diaphragm and the metal deposit.

A microphone for airborne sound is usually protected by being enclosed in a housing with a protective grille. When a microphone of the construction outlined above is used in direct contact with a surface, such as the skin of a body, the bodily sounds of which are to picked-up, there is no distance to protect the diaphragm from being hit by objects. It is one object of the invention to provide a protection for such microphones that will prevent the piezoelectric layer from cracking.

A microphone is usually regarded as an expensive transducer with a long service life. In case it is used in disposable applications, such as in surgery, where sterilization is required, this is normally solved by enclosing the microphone in a disposable sleeve, which is discarded after use. However, this approach requires surgical assistants to handle small items at a time where their attention could potentially be required for more urgent matters. There would hence be a need for a disposable microphone, and this is a further purpose of the invention.

Normally, the connection to a transfexural diaphragm element is perfomed by spot welding or soldering to the metal diaphragm and soldering to the metal layer, in

particular in those applications where the transflexural diaphragm element is used as a piezo-buzzer. When the transflexural diaphragm element is used as an input device it is very important that electrical noise signals are not injected in the circuit, and this can only be obtained by keeping the connecting leads very close together. In applications where it is important to have a disposable or one-time-use unit, the manufacture of such units must be in volume, with as small cycle-times as possible. In such circumstances, operations such as soldering, cutting to specific lengths, insulating, and connecting the other end of the connecting wires to the interface leads must be regarded as very time-consuming, and this traditional method of manufacture does not ensure that the closeness of the leads is maintained. It is a further object of the invention to provide an efficient method for the manufacture of such a microphone.

The above objects are fulfilled in a microphone component according to the invention, which is particular in that the signal interface element is a printed circuit with a stiffness below that of the piezoelectric transflexural diaphragm element, and in that the mechanically protective front surface is an elastic metal disc of the same dimensions as the piezoelectric transflexural diaphragm element, the supporting layers between said disc and said piezoelectric transflexural diaphragm element comprising a foam layer. This printed circuit makes contact to the side of the piezoelectric transflexural diaphragm element where there is access to both the metal diaphragm and the metallization, and the leads are taken from the diaphragm element while in close proximity, preferably because they are on either side of a double-sided flexible print.

The elastic metal disc is preferably a stainless steel disc, and it has surprisingly turned out that even hitting a corner of an object to the degree of indenting the disc visibly will not crack the piezoelectric transflexural diaphragm element. This is attributable to the force distributing qualities of the supporting foam.

The piezoelectric transflexural diaphragm element is a high-impedance element, and a series resistance of up to about 100 ohms in the connection is easily absorbed. For this reason it has been determined that it is feasible to establish a connection between the printed circuit and the appropriate locations on the piezoelectric transflexural

diaphragm element by means of conductive tape. Traditionally, this would have been in the form of cut-outs corresponding to the areas of contact, but in the present invention use is made of an anisotropic conductive tape, which is only conductive along its thickness, and hence the whole area of the piezoelectric transflexural diaphragm element may be covered without detriment to its performance.

The microphone component according to the invention may be placed in any cavity in a carrier body commensurate with the dimensions of the microphone component. It is in accordance with its principle of working that it is supported by a ring-shaped step in a hole, however the provision of foam on the reverse side of the piezoelectric transflexural diaphragm element will enable it to function also in a simple, cylindrical cavity (in the case of a circular element).

In an advantageous embodiment of the invention the printed circuit additionally carries an impedance converting semiconductor component. This means that the signal wires are less susceptible to electric noise. The semiconductor component, which may be a small integrated circuit, may be provided with power by a phantom circuit.

An advantageous extension of the idea of the invention is particular in that several piezoelectric transflexural diaphragm elements are connected by one and the same structure consisting of anisotropic tape and a flexible printed circuit. The printed circuit will provide individual signal connections and also individual impedance converters as required. This will *inter alia* permit the use of a diversity reception type selection of the best signal receiver at any one instant.

The invention will be described in greater detail with reference to the drawing, in which

Fig. 1 shows an exploded view of a microphone component according to an embodiment of the invention and seen from the front, and

Fig. 2 shows an exploded view of a microphone component according to the same embodiment of the invention and seen from the back.

In Fig. 1 are seen the elements of the microphone component separate from the housing into which it is placed, preferably in such a way that the front of the microphone component is flush with the surrounding front surface of the housing. It is expedient to explain the construction while describing the manner in which it may be assembled. All the elements are circular and are prepared before assembly. A foam pad 1adheres to a double-sided adhesive tape 2 that attaches it to the all-metal side (see Fig. 2) of a piezoelectric transflexural diaphragm element 3. An anisotropic conductive tape 4 being adhesive on both sides establishes connection to the side of the piezoelectric transflexural diaphragm element 3 that displays the naked metal diaphragm 5 surrounding the metallized surface 6 of the piezoelectric layer. A conducting ring 7 (see Fig. 2) formed on a small circular printed circuit 8 is connected to the metal diaphragm via the anisotropic conductive tape, and the metallized surface is similarly connected to a centrally placed conductive pad 9 (see Fig. 2) on the printed circuit. The pad is plated through a hole in the insulating material part of the printed circuit to the other side, where a printed conductor 10 on a tab takes the signal to a terminal 11 somewhat removed from the circular elements. Similarly, the conducting ring 7 has a printed conductor 12 placed precisely opposite the printed conductor on the other side (see Fig. 2) and brought to a terminal 13. In this manner, electric contact has been established to the piezoelectric transflexural diaphragm element, and the conductor 12 corresponding to the metal diaphragm 5 will be considered the ground connection. The close proximity between the two conducting strips will ensure EMC. In a similar embodiment, the printed circuit is single-sided, and the ground connection is formed as a guard ring around the centrally placed conductive pad and is brought down on either side of the central conductor on the strip.

A foam pad 14 with one adhesive side is placed on the reverse side of the printed circuit 8, and a double-sided adhesive tape 15 adheres a stainless steel diaphragm 16 to the foam pad 14. The stainless steel has a typical thickness of 150 μm and forms the outer surface. The whole microphone component may be mounted in a cavity in the housing in two ways, bearing in mind that the intention of the embodiment described is to provide a single-use microphone component. One method is to provide the innermost foam pad 1 with an adhesive that is protected by a release slip

to be removed before placing the microphone component in the cavity and pressing it to the bottom of the cavity. Another method is to provide a safety-pin-like clip placed diametrically across the protective stainless steel diaphragm 16. When the microphone component is to be replaced, the clip is opened, the used component is extracted by pulling the printed circuit strip, the new and sterile component is placed in the cavity, and the clip is closed. A clip of this kind will provide a ground connection to the protective stainless steel diaphragm 16, and thereby improve the screening of the piezoelectric transflexural diaphragm element.

All the elements are manufactured beforehand and assembly into one microphone component is extremely well adapted to automatic assembly. Essentially, the elements are centred (brought into register in order to become coaxial) and stacked in any order that provides a correct assembly, and simple stacking may be completed by pressing with a pre-determined force in order to assure bonding between the various adhesive components.

The foregoing description of the specific embodiments will so fully reveal the general nature of the present invention that others skilled in the art can, by applying current knowledge, readily modify or adapt for various applications such specific embodiments without undue experimentation and without departing from the generic concept, and therefore, such adaptations and modifications should and are intended to be comprehended within the meaning and range of equivalents of the disclosed embodiments. It is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation. The means, materials, and steps for carrying out various disclosed functions may take a variety of forms without departing from the invention.

PATENT CLAIMS

1. A microphone component comprising at least one piezoelectric transflexural diaphragm element (3), a signal interface element comprising conductors (10, 12), support elements and a mechanically protective front surface, characterised in that the signal interface element is a printed circuit (8) with a stiffness below that of the piezoelectric transflexural diaphragm element (3), and in that the mechanically protective front surface is an elastic metal disc (16) of the same dimensions as the piezoelectric transflexural diaphragm element, the supporting layers between said disc and said piezoelectric transflexural diaphragm element comprising a foam layer (14).

2. A microphone component according to claim 1, characterised in that said elements are circular and coaxial.

3. A microphone component according to claim 1, characterised in that the signal interface element (8) is connected to the piezoelectric transflexural diaphragm element (3) by means of conductive adhesive tape patterned to correspond to terminal areas (5, 6) on the piezoelectric transflexural diaphragm element (3).

4. A microphone component according to claim 1, characterised in that the signal interface element (8) is connected to the piezoelectric transflexural diaphragm element (3) by means of an anisotropic conductive tape (4).

5. A microphone component according to claim 1, characterised in that it is adapted to be removably fixed in a cavity by means of a foam pad (1) that is supplied with an adhesive layer protected by a removeable cover to be removed before fitting the microphone component into the cavity.

6. A microphone component according to claim 1, characterised in that it is adapted to be removably fixed in a cavity by means of a clip across the elastic metal disc (16) that simultaneously establishes an electrical ground connection to said disc.

7. A microphone component according to claim 1, characterised in that the printed circuit carries an impedance converting component or components in proximity to the piezoelectric transflexural diaphragm element (3).

8. A microphone component according to claim 1, characterised in that it comprises a plurality of piezoelectric transflexural diaphragm elements (3), each individually connected to terminals (7, 9) on one and the same printed circuit (8).

9. A method for the manufacture of a microphone component according to the above claims, characterised in that it comprises the following steps:

a) provide foam and tape elements by stamping out of sheet material

b) centre a double-sided adhesive tape (15) on metal disc (16),

c) centre foam pad (14) on double-sided adhesive tape (15),

d) centre printed circuit (8) on foam pad (14), conductor (10) facing foam pad (14),

e) centre an anisotropic tape (4) on printed circuit (8),

f) centre piezoelectric transflexural diaphragm element (3) on anisotropic tape (4), establishing electrical contact to both electrodes (5, 6) of the piezoelectric transflexural diaphragm element (3),

g) centre a double-sided adhesive tape (2) on the metal back of the piezoelectric transflexural diaphragm element (3),

h) centre a foam pad (1) on double-sided adhesive tape (2).

10. A method similar to claim 9, characterised in that steps b) - h) are taken in reverse order.

ABSTRACT

Piezoelectric transflexural diaphragm elements are useful as microphone elements, however they are fragile, and particularly vulnerable when placed flush with the surface of a housing to be in contact with a living body. According to the invention a microphone component has been developed, which is both rugged and amenable to very inexpensive manufacture. This is obtained in a laminated construction comprising a foam layer supporting a protective elastic metal disc, in which the electrical connections are made by a printed circuit.

(Fig. 1)

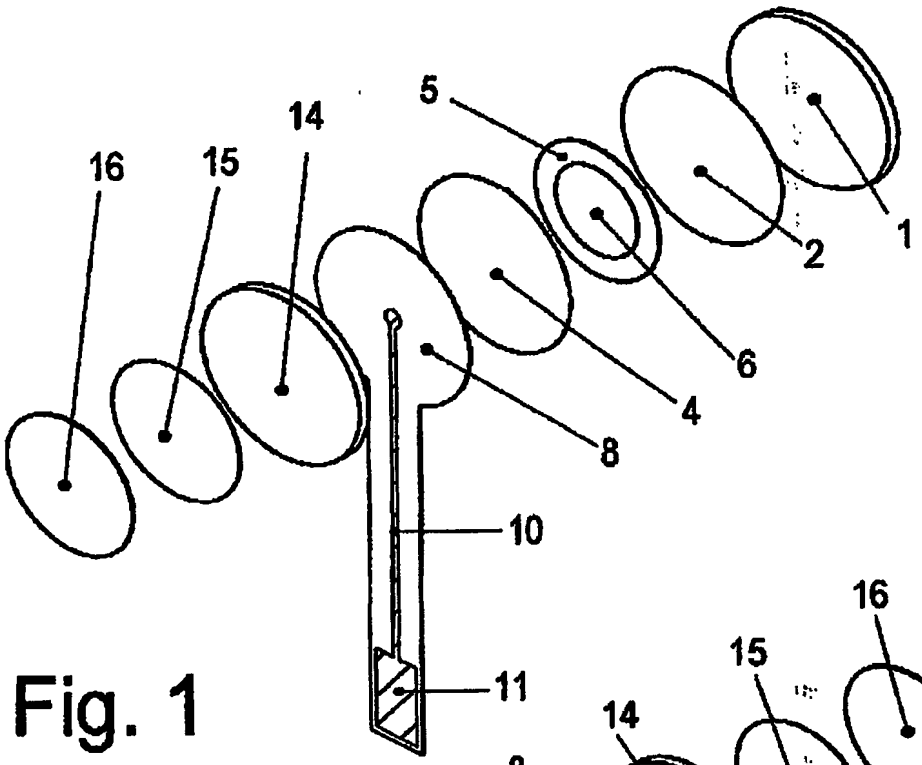

Fig. 1

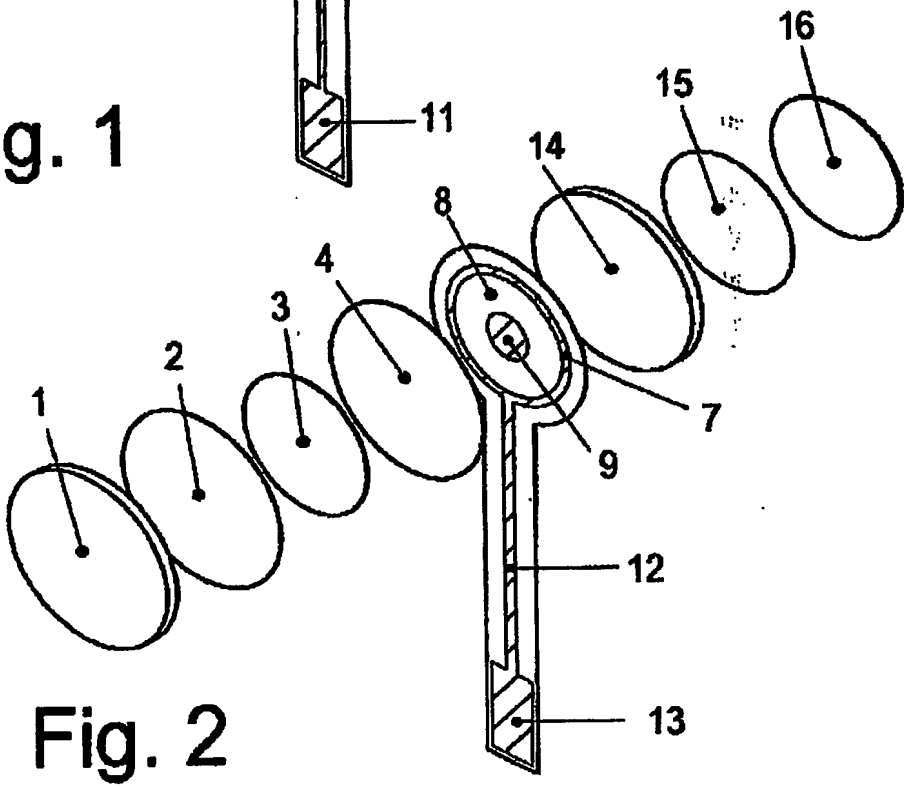

Fig. 2

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Med venlig hilsen,

George Brock-Nannestad

Bilag.

ABSTRACT

Piezoelectric transflexural diaphragm elements (3, 5, 6) are useful as microphone elements, however they are fragile, and particularly vulnerable when placed flush with the surface of a housing to be in contact with a living body. According to the invention a microphone component has been developed, which is both rugged and amenable to very inexpensive manufacture. This is obtained in a laminated construction comprising a foam layer (14) supporting a protective elastic metal disc (16), in which the electrical connections are made by a printed circuit (8).

(Fig. 1)

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